Building Research Establishment Digest

CI/SfB			DIGEST
(3-)	(Xi)	(L6)	73

New edition 1978

Prevention of decay in external joinery

Reports of 'wet rot' in external joinery, particularly in new houses, suggests that the factors responsible are not as widely understood as they should be. This Digest examines the causes of decay and makes recommendations as to its prevention.

Some progress has been made: window joinery should have been preservative treated in houses built privately since 1970 and preservative treatment has been recommended for external soft-wood panelled doors since 1975.

If mass-produced external joinery is used, preservative treatment should be part of the purchase specification.

Incidence

Decay in exterior windows and doors has always occurred sporadically, but the number of reported cases of decay has increased appreciably over the past few years and is found even in joinery complying with current Codes of Practice and Specifications. Window joinery in newly built houses has given most cause for complaint; decay has sometimes become a serious problem within five or six years from the time of construction. Usually, decay has been noted earlier in the wetter, western areas of the British Isles though it has by no means been confined to these regions. Recent surveys have also revealed a high incidence of decay in untreated, mass-produced, external panelled doors which are not fully protected from the weather by porches, etc.

While decay may occur anywhere in opening lights and in frames permanently in contact with brickwork or blockwork, it is particularly marked in ground floor windows, especially kitchen and bathroom windows. The lower parts of these windows, ie the cills, the bases of jambs and mullions and the lower rails of opening lights, are particularly susceptible.

Type and symptoms

Almost invariably decay is of the wet rot type. This means that the fungi responsible, unlike the dry rot fungus, will not spread the rot to other woodwork in the building. Discoloration of the paintwork and 'cupping', or softening of the underlying wood, are the usual first symptoms of decay. Later, cross-cracking and dark discoloration of the wood itself may be observed. Sometimes in the later stages the wood becomes soft and stringy. There is no evidence of Baltic redwood having been infected prior to manufacture by the fungi responsible for wet rot.

Causes and prevention

Decay is caused by timber of low natural resistance becoming sufficiently moist to allow wood-destroying fungi to grow. Prevention of decay therefore depends on the selection of timber which is either naturally resistant to decay or which is otherwise protected by preservative treatment. Only heartwood has natural resistance to decay; sapwood* *must* be excluded where preservative treatment is not used.

* Sapwood cannot economically be excluded from joinery grade redwood.

Prepared at Princes Risborough Laboratory, Princes Risborough, Aylesbury, Buckinghamshire.
Technical enquiries arising from this Digest should be directed to Building Research Advisory Service at the above address.

Moisture control

Irrespective of the species of timber employed, adequate seasoning to remove moisture is essential before manufacture as joinery. A low moisture content restricts dimensional changes, permits satisfactory painting and contributes generally towards decay prevention. After seasoning, further access of moisture should be restricted:

by good design and careful fabrication of the joinery itself, particularly of the joints;

by storage indoors or raised clear of the ground and covered with waterproof sheets to protect the woodwork from exposure to the weather prior to final installation and painting;

by good detailing at the window/wall joint;

by thorough painting and regular maintenance;

by prompt attention to any necessary repairs.

Timber and its selection

Timbers for mass production joinery are chosen mainly because they are inexpensive and easily machined, not because they are particularly resistant to decay.

Baltic redwood (also known as red or yellow deal, red pine or fir) is the softwood most used for exterior joinery; its heartwood is more resistant to decay than its sapwood. The heartwood of Douglas fir is also used.

English oak is the traditional hardwood for exterior joinery, especially cills, in which greater resistance to decay is an asset. The hardwoods teak, utile, gurjun and agba have also proved acceptable. All these should be specified by name; merely to specify 'hardwood' can lead to the use of unsuitable timbers such as abura, beech, obeche and ramin (all with poor resistance to decay). The inclusion of perishable sapwood of an otherwise decay-resistant timber can be avoided by specifying 'Heartwood only'.

Suitable timber species and their properties are set out in Table 2 (on page 7), extracted from CP 153 : Part 2 : 1970.

As Baltic redwood predominates in window joinery in the United Kingdom, the remarks which follow apply mainly to this timber. However, the principles of prevention and treatment of timber decay do not vary much between any of the different species used.

Preservative treatments

Care in design, construction, handling and maintenance can reduce but not eliminate the risk of decay. The obvious but often too costly remedy is to use naturally durable timber, excluding all sapwood. Alternatively, the risk of decay can be eliminated by adequate preservative treatment.

Recommended preservative treatments include:

Vacuum/pressure impregnation with water-borne preservative
Complete penetration of the sapwood of Baltic redwood can be achieved by this method. Treatment with an aqueous solution and the subsequent redrying that is necessary, however, cause the wood to swell and then to shrink; this can result in some raising of the grain and a risk of distortion.

Double-vacuum treatment with organic-solvent type preservative
The degree of treatment obtained can be controlled by varying the treating cycle used and it is possible to ensure that the net retention of the relatively high-cost preservative is adequate but not excessive. Complete penetration of sapwood is not usually obtained, but the average absorption and penetration achieved is about twice that from immersion treatment below.

Diffusion treatment This is carried out at the sawmill; after processing, seasoned treated timber can be supplied to the joinery manu-

facturer already penetrated throughout with a water-soluble preservative. This stock can then be converted and assembled in exactly the same way as untreated wood. Because the preservative is water-soluble, there is a risk that some may be leached out if the joinery is exposed to rain for months without paint or other protection.

Immersion treatment with organic-solvent type preservative
Machined components or assembled units are submerged in a tank of preservative for three minutes. This provides satisfactory protection even though sapwood penetration is incomplete. Preservatives used for immersion, and for double-vacuum treatment, often contain water repellents: these improve the dimensional stability of the wood and hence benefit the performance of the joinery.

For further information on preservative treatment see PRL Technical Note 24, *Preservative Treatments for External Softwood Joinery Timbers*; this includes a list of the commercial processes and preservatives suitable for the treatment of external joinery.

Compatibility with glues, paints, mastics, etc, used subsequently should be established with the manufacturers.

Design and fabrication of joinery

Entry of water is most likely to occur at joints. Some modern joints loosen more easily than the old-style mortice-and-tenon joints with wedged tenons, and are therefore more vulnerable to water penetration. Joints are usually made with the grain of one member at right angles to that of another. Quite small fluctuations in moisture content stress these joints severely and once cross-grain movements begin, more water can enter and threaten decay.

The animal and casein glues permitted by some joinery specifications are likely to fail in persistently moist conditions. When this happens the joints in doors and opening sashes are less able to resist sudden stresses; the joints loosen, the paint film is broken, and penetration by moisture follows. The modern, synthetic resin glues are preferred because of their greater resistance to moisture. (See Forest Products Research Bulletin 38, *The efficiency of adhesives for wood.*)

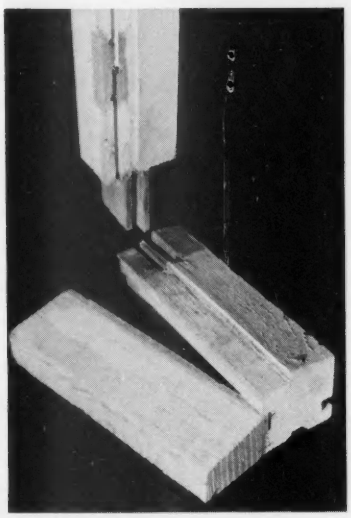
The sectional sizes of timber scantlings accepted for windows have become smaller in recent years. It is bad practice to employ flimsy sections in window joinery, particularly where weather conditions are severe, as in some parts of Scotland. Such sections are prone to distort, permitting ingress of moisture, and they may not provide adequate space for the rebate. In opening lights the strength may be insufficient to prevent racking and consequent water penetration at the joints.

Window designs with horizontal surfaces which do not effectively shed water, still more those that actually entrap it, should be avoided. This applies both to rain-water on the outside of the window and to condensation on the inside.

The present-day omission of condensation channels and adequate means of drainage from them is to be deplored. Often water stands on the sill against the bottom of the frame and seeps into the joint between the two.

Cills present problems because they require timber of larger dimensions, and hence of greater cost, and also because they tend to present a higher decay risk. Whilst decay risk can be met by using more durable timber, increased cost is involved even if such timber is restricted to the cill alone. The current trend is to reduce costs by building up the cill from two smaller dimension timbers; the increased complexity of the two-piece unit calls for greater care in design and manufacture. However, even when Baltic redwood is used, a properly designed jointed cill effectively glued with suitable adhesives and preservative treated as necessary should give adequate service.

Fig 1 Complexity of joint design in a modern frame and cill. Result—joints expose a large surface area to risk of moisture penetration and facilitate decay



Weather protection before installation

Joinery is often to be seen exposed to all weathers while in transit or awaiting installation on building sites. This is thoroughly bad practice. All woodwork should be fully protected from the weather and stacked clear of the ground. Pink primer may look protective but it is rarely effective in preventing penetration of moisture—moisture which may later cause trouble is trapped by relatively impermeable coats of paint.

The window/wall joint

A further contributory cause of moisture penetration, and therefore of decay, may arise from contact between window frames and wet brickwork. There is rarely any damp-proof barrier separating them, nor is it usual to protect the backs of the frames with extra paint before installation. Even when the joinery is set in the inner leaf of brickwork there is risk of dampness continuing in the frames for as long as it takes the brickwork to dry out.

The more usual practice, however, except in Scotland, is to set the frame in the outer leaf of brickwork; not only is this brickwork often permanently damp, the window itself is much more directly exposed to the weather. Clearly this practice carries the greater risk of timber decay. Thorough priming—two full coats of an aluminium based primer—is needed on all timber surfaces that are to be in contact with external walls.

External and internal climates

The direct exposure of windows to driving rain and to rain-water run-off will depend on their regional location and position in the building, ie storey height and orientation (see Digest 127). That decay tends to be most marked in the lower, external parts of ground-floor windows is only to be expected. However, too little thought is given to the effects of internal climate on window joinery; this can be as damaging to the woodwork of single-glazed windows as the weather outside. In bathrooms and kitchens especially, temperature and humidity are often high, and in cold weather condensation on these windows is troublesome. Changed living habits and heating methods have aggravated the problem (see Digest 110). Often there is a pool of water along the lower edge above the back putty. This back putty is rarely as free from defects as that on the face, and water finds an easy entry. (The need for condensation channels at the base of the frame has already been mentioned.)

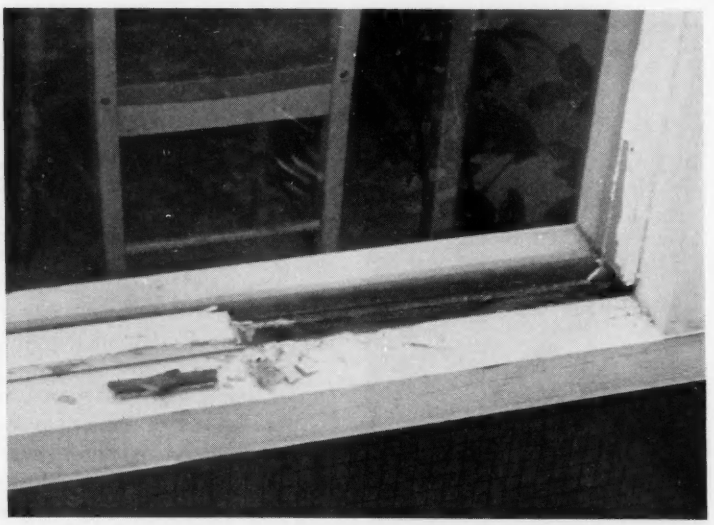


Fig 2

Outer glazing bead nailed—not glued or sealed. Result—free moisture penetration.

Grooves machined for outer glazing bead run right through mullion/transom joint. Result—void for collection of moisture

Fig 3 External part of mullion/transom joint held by nail. Result—water penetrates freely once the paint film is broken. Failure through decay began after three years' service

Painting and maintenance, primers

(*see also* Digest 106)

As noted, the ability of a single coat of primer, even a good quality lead-based type, to prevent ingress of water is greatly over-estimated. 'Pink' shop primers are of variable quality and many do little more than give the joinery a uniform appearance; after quite a short exposure they become weak or powdery and unfit to take further coats of paint. Many paint failures can be traced back to poor quality primers. Thus it is most important to store joinery under cover; if this is considered impossible much better priming than usual should be specified. A water-repellent preservative plus a good quality primer, or two coats of aluminium primer, would be suitable. (Since aluminium primers will also keep moisture in, they should only be used on correctly seasoned timber, or after the moisture or solvent from preservative treatment has dried out, otherwise blistering may occur.)

Lead-based pink priming paints (BS 2521 :1966) have been regarded as having maximum durability, both as part of a full paint system and if left exposed on site. They are expensive and their toxicity makes their

Fig 4 Gap left beneath tenon in joint between stile and cill or, in this case, between lower rail of main frame and base of mullion. Result—void for collection of moisture and eventual decay

Fig 5 Cupping of paintwork and putty failure associated with decay in lower rail of an opening light

use indoors inadvisable where children could contact them (even under further paint). BS 5358 : 1976 specifies low-lead primers with performance as good as that of lead-based ones.

Acrylic emulsion-based primers, preferably to BS 5082, are often used because they are convenient for joinery manufacturers and are virtually lead free. Although their water resistance is lower than that of the best oil-based primers, they have high durability before and after painting. 'Primer undercoats' may be less durable outdoors.

If a thin, weak or powdery shop coat is present, it should be sanded and a further coat of good quality primer applied. End grain and surfaces in contact with brickwork or masonry should always receive an extra coat of primer. Poor quality putty cracks or loses adhesion easily and allows water to enter at the bottom rail : all putty should be completely painted, with a slight overlap on to the glass. Hardwood cills should have the grain filled with a knifing stopper or filler (not a water-mixed type), preferably between two coats of primer.

Shellac knotting, even if it holds back resin, usually permits adhesion failure of the paint coats; an aluminium pigmented knotting is preferable, but good practice requires large knots to be cut out and the cavities to be stopped.

Selection of species

A guide to the choice of timber species is given in the tables. The classification in Table 1 is based upon general experience of the probable protection requirements needed to ensure satisfactory service. Information on individual timbers is given in Table 2. The terminology used is explained in 'A Handbook of Hardwoods' and 'A Handbook of Softwoods' prepared by Princes Risborough Laboratory and published by Her Majesty's Stationery Office.

Table 1 Protective treatment required

Class	Durability	Sapwood	Protection Needed	
			Preservative Treatment	Finishes[2]
1	Very durable	Must be excluded[1]	Not necessary	For decorative purposes and to protect surface from weathering
2	Durable	Must be excluded[1]	Optional	
3	Moderately durable	Must be excluded[1]	Optional	Protective surface finish essential; should be well maintained
4	Perishable or non-durable	Assumed to be present	Essential	

1. If this is not done the timber, irrespective of species, must be regarded as class 4. Preservative treatment is then essential.
2. These include paint, natural or synthetic varnishes, pigmented water-repellent preservative stains.

Table 2 Timber species and properties

Class and heartwood durability†	Standard name	Sapwood distinct	Resistance to impregnation with preservatives	Woodworking properties		Amount of movement on re-wetting	Paint performance in service	Remarks
				Resistance in cutting	Blunting effect			
Class 1 Very durable	Afrormosia	Yes	Extremely resistant	Medium	Moderate	Small	Good, provided paint is not affected by oily exudations	Non-ferrous fitments necessary
	Afzelia			High	Moderate	Small	*	May discolour other building materials
	Iroko			Medium	Fairly severe	Small	*	
	Kapur			Medium (variable)	Moderate (occasionally severe)	Medium	*	Non-ferrous fitments necessary
	Makoré			Medium	Severe	Small	*	Non-ferrous fitments necessary
	Teak				Fairly severe (variable)	Small	Good, provided paint is not affected by oily exudations	Has been known to cause discoloration of granite
Class 2 Durable	Western red cedar	Yes	Resistant	Low	Mild	Small	Good	Strenght relatively low. Non-ferrous fitments necessary to avoid marked discoloration of the wood under clear finishes
	Agba	Moderate		Medium	Moderate	Small	Moderate, but experience is limited	Log core may contain brittleheart. Resin exudation may occur with some parcels, especially if the timber has been air-dried
	European oak, American white oak, Japanese oak	Yes	Extremely resistant	Medium (variable)	Moderate (variable)	Medium	Poor	Non-ferrous fitments necessary. Occasionally disfigures other building materials
	Idigbo	Moderate			Mild	Small	*	Log core may contain brittleheart. May cause staining of other building materials
	Sweet chestnut	Yes		Medium	Mild	Small	*	Non-ferrous fitments necessary
	Utile				Moderate	Medium	Good	
Class 3 Moderately durable	Douglas fir	Yes	Resistant	Medium	Medium	Small	Moderate	Non-ferrous fitments advisable
	African mahogany		Very resistant	Medium (variable)	Moderate (variable)	Small or medium	*	Log core may contain brittleheart
	Gurjun Yang		Resistant	Medium (variable)	Moderate (occasionally severe)	Large	Moderate	Resin exudation occurs with some parcels of these timbers (especially keruing); select material free from resin for painted work
	Keruing					Medium	Moderate	
	Red meranti Red seraya	Moderate				Small	*	Log core may contain brittleheart
	Sapele	Yes	Extremely resistant	Medium	Moderate	Medium	Good	
Class 4 Perishable or non-durable	Redwood	Yes	Sapwood permeable Heartwood moderately resistant	Low	Mild	Medium	Good	
	Western hemlock	No	Sapwood and heartwood resistant	Low	Mild	Small	Good	
	Whitewood							
	American red oak	Yes	Sapwood permeable Heartwood resistant	Medium	Moderate	Medium	Poor	Non-ferrous fitments advisable
	Beech	No	Permeable	Medium (variable)	Moderate (variable)	Large	Good	
	Ramin			Medium	Moderate	Large	Moderate, but experience is limited	

† When sapwood is present, the timber should be preservative-treated regardless of the durability of the heartwood.

* Seldom painted; there is therefore little painting experience.

Treatment of decay

It is important that all decayed wood should be cut out and paint stripped from adjacent areas so that damp, but not rotten, timber can be given a chance to dry out. If decay is extensive the entire window unit may have to be replaced. Wood exposed by cutting should be treated liberally with a paintable preservative, again allowed to dry, then given a coat of primer. Depending on their size, holes should be made good with stopper or primed timber, suitably shaped. Another coat of primer should be applied to the new surface, followed by undercoat and finishing coats. If paint has been stripped from cills and lower rails of windows, a wise precaution is to apply a liberal treatment of preservative and allow to dry for a few days before priming.

New methods of *in-situ* treatment such as injection of preservative are becoming available. Their ultimate value has not yet been determined but they show sufficient promise to warrant consideration.

Recommendations

1 When making use of Specifications and Codes of Practice bear in mind that their requirements may not be adequate in every circumstance to ensure satisfactory durability of the timber.

2 To ensure adequate service from Baltic redwood and other timbers of low decay resistance, insist on preservative treatment, if necessary with a paintable preservative.

3 If durable hardwood is to be used specify the timber by name and insist on the exclusion of sapwood.

4 Protect joinery from the weather during delivery to the site, and on the site before installation.

5 Refuse to accept low quality shop primers. Specify British Standard primers. Ensure an adequate painting system and sound putty.

Other BRE Digests

72 Home-grown softwoods for building
106 Painting woodwork
110 Condensation
127 An index of exposure to driving rain
182 Natural finishes for exterior timber
201 Wood preservatives: application methods

Department of the Environment **Building Research Establishment**

© Crown copyright 1978

Published by Her Majesty's Stationery Office and printed in England by W & J Mackay Limited, Chatham.
Single copies 12p each. Annual subscription inclusive of postage £2.28.
Quantity rates (excluding postage) for bulk supply of any one Digest: 50 for £4.80.

Dmd. 587675 K105 2/78 ISBN 0 11 721483 3